Reducing Shipment Variability through Lean Leveling

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Topic Area: Distribution, Variability, Lean Principles

Summary: This research focused on reducing shipment variability between manufacturer warehouse and customer distribution center. We used the leveling principle as defined by lean theory to create predetermined customer shipments for the top selling SKUs. We determined the optimal degree of lean leveling implementation through simulation analysis of various order policies. Sending frequent, small, recurring shipments on a weekly basis could lead to improvements in service level, transportation cost and cash.

Before coming to MIT, Melissa Botero worked for five years for Cementos Argos (Colombia). Prior to that, she graduated with a Bachelor's degree in Industrial Engineering from Escuela de Ingeniera de Antioquia. Upon graduation, Melissa will continue working with Cementos Argos as a Supply Chain Project Manager.

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KEY INSIGHTS

1. Managing shipment variability is a key challenge for supply chain professionals. While reducing variation across the supply chain has limits, each minor advancement effort could yield improvements reflected in the company profitability and customer satisfaction.

2. Lean principles have been applied extensively in manufacturing settings, while the logistics domain remains a relatively unexplored lean frontier.

3. Lean leveling aims to reduce variability through the more frequent production of top selling SKUs. Applying the lean leveling principle to distribution can improve service level, transportation cost and cash (working capital tied up in inventory).

Introduction

Supply chain professionals are often confronted with the increasingly difficult task of meeting service promises while operating with high variability in order patterns. This volatility leads to supply chain-wide inefficiencies, high operational complexity, low service levels and substantial costs. These challenges are particularly prevalent among companies operating in the consumer goods industry due to the vast numbers of ever changing SKUs and the frequent use of promotions. Weeks of consistently over ordering certain items are often followed by periods of close to zero orders of the same item. Our research focused on applying the lean leveling principle as a measure to counteract the challenges posed by oscillating order placement.

The current highly volatile order system poses key challenges to the sponsor company. The company often has to pay a premium freight rates to fulfil service level promises. Furthermore, both buyers and sellers hold higher levels of inventory as a contingency plan to buffer against unpredictable peaks in demand. The motivation for this research was to achieve a more uniform flow of goods and thereby addressing the root cause instead of curing symptoms.

Leveling distribution can make the shipping process more predictable and therefore easier to manage. Whereas lean concepts have been applied extensively to the manufacturing domain, lean application in distribution processes has received relatively little attention in practice. We simulated various order policies based on lean levelling principles with the goal of improving operational performance across supply chain echelons.

Creating a new Order Policy

The research focused on diminishing the impacts of variability by creating more stable inventory flows between a supplier warehouse and a retailer's distribution center. Figure 1 depicts the degree of shipment variability experienced by a typical customer of the sponsor company under the current order system. The range of 5 to 22 weekly shipments confirmed the need to address the issue of volatility.

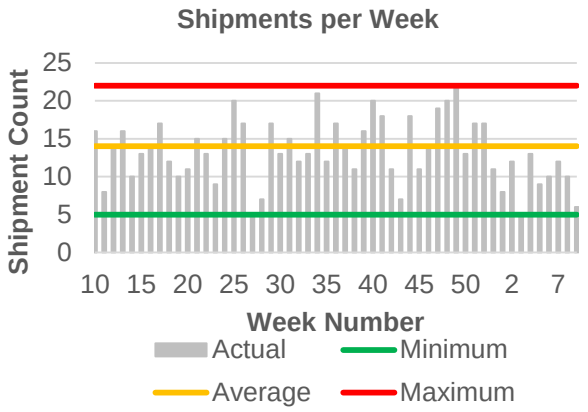

Figure 1: Weekly Shipment Variability

We developed a model based on one year of historical demand, supply and forecast data. We created a new order policy based on the following 3 key steps: SKU segmentation, simulation, evaluation.

1. SKU segmentation

We utilized lean theory to develop a new order policy with the goal of smoothening out demand volatility. Under lean theory, a daily fixed production plan is applied for the top 50% of SKUs. The daily manufacturing of the same products allows the manufacturing team to develop experience on the process, standardize it and improve it, something known as "Economies of repetition."

Following the lean leveling principle derived from the manufacturing domain, we conducted a SKU segmentation to identify the top selling 50% of SKUs. The resulting top SKUs were used to find the base quantity by SKU to be shipped continuously under the new policy.

2. Simulation

We built a model to simulate the effects of the new order policy based on varying degrees of lean implementation, in order to determine its viability. The simulation determined the number of cases ordered by week, inventory levels, and anticipated lost sales by week and by SKU.

The new policy consisted of two components: a fixed part and a variable part. The fixed part was comprised of a percentage of the base quantity derived from the segmentation analysis. The variable component follows the process logic of the sponsor company, taking into account current inventory levels, demand forecasts and promotional data. Figure 2 shows the reduction in weekly shipment variability under the new order policy. In this figure, the adjustable fixed order percentage was set at the default rate of 50% of the average.

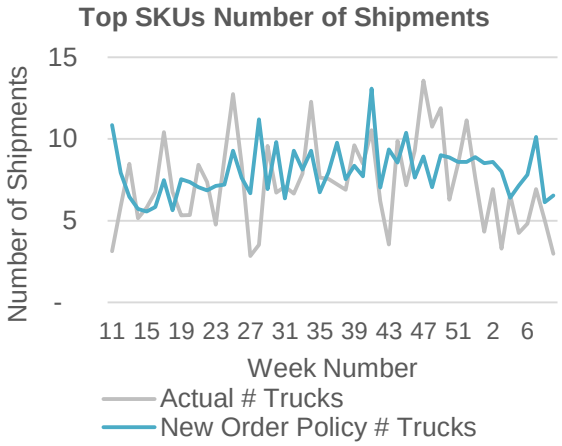

Figure 2: New Order policy vs Actual Performance

Under the new policy, the fixed order component represents a consistent minimum shipment level which enables the overall reduction in volatility. At the same time, the variable order component gives the company the flexibility to cover sudden demand peaks.

3. Evaluation

The results of the simulation runs were compared with the actual performance of the sponsor company according to the following criteria: cash (inventory levels), transportation cost and service level. An improved inventory policy should be based on an approach that balances the three criteria. This enables sustained gains for both buyers and sellers across the supply chain.

To obtain the optimal inventory order policy, we conducted a sensitivity analysis based on the adjustable percentage of fixed versus variable shipments. Figure 3 shows the impact of the fixed order percentage on the three evaluation criteria.

The more fixed shipments a company has, the more shipments can be planned in advance, which reduces the probability of having to pay for premium freight rates. Therefore, the transportation cost decrease as the fixed percentage of the average increases.

Under the new order policy with fixed recurring shipments, the sponsor company can rely on the same carrier and even the same drivers, which will create efficiencies out of habit. Overall, the probability of a shipment arriving on time increases with a higher rate of fixed shipments.

More frequent deliveries reduce inventory requirements at the customer warehouse. However, inventory levels become increasingly inflated with a rising fixed percentage because available quantities start to exceed demand levels more often.

Since all three evaluation criteria had to at least remain the same under the new policy, the team established a feasible region with potential order policies. At a fixed order percentage of 75% the three evaluation criteria were equally balanced between buyer and seller.

Conclusions

Shipping variability affects the performance of every global supply chain. Causes such as changing customer behaviors, lack of coordination between supply chain partners, and disruptions prevent companies from achieving a more uniform flow of goods. We demonstrated that lean leveling could effectively reduce shipment variability while leading to improvements of service levels, transportation costs and cash requirements.

Operating with the lowest possible shipping variability does not necessarily lead to the best results due to the highly volatile nature of the consumer goods industry. Instead, reducing shipment variability should be seen as a means to the end of improving cash requirements,

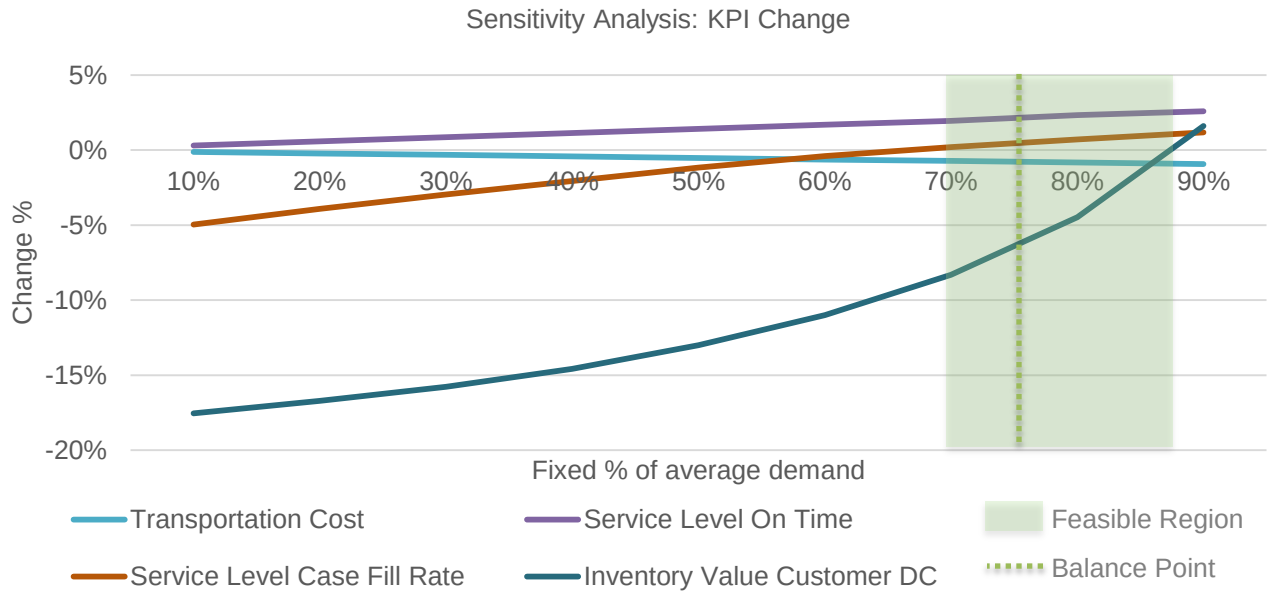

Figure 3: Sensitivity Analysis of adjustable fixed order percentage

transportation cost, and service level. For an optimal strategy, companies should find a balance of fixed and variable shipments of the top selling SKUs. Companies should further balance the evaluation criteria to potentially enable sustainable gains for both buyers and sellers. Sending frequent, small, recurring shipments of the Top SKUs on a weekly basis could lead to better operational performance than infrequent bulk shipments of the same items.

A careful analysis of the order policies should be conducted with the goal of determining the optimal degree to which lean leveling should be applied. An order policy, combining the synergies gained from lean leveling while maintaining the flexibility to respond to unusual demand volatility, could lead to a win-win situation in the long run.